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Correlation between Inferior Vena Cava Collapsibility Index (IVCCI) and Brain Natriuretic Peptide (BNP) to Assess Stroke Volume in the First One Hour of Sepsis Patients at ICU Haji Adam Malik Hospital Medan

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Abstract:-
Objective: To determine correlation between inferior vena cava collapsibility index (IVCCI) and brain natriuretic peptide (BNP) level to assessing one hour bundle success of septic patients treated at ICU Haji Adam Malik Hospital Medan.

Methods : This study is an observational analytic study with cross-sectional survey design conducted at the Haji Adam Malik General Hospital Medan Intensive Care Unit (ICU) on 37 samples. Inclusion criteria are age d 18-65 years who admitted in ICU with sepsis, burn injury are excluded. Correlation data analysis use Spearman test with SPSS.

Results : The mean inferior vena cava collapsibility index (IVCCI) in septic patients treated at ICU Haji Adam Malik Hospital Medan was 1.65 ± 0.73 with decreased in 20 people (50%), normal in 14 people (35%) and increased in 6 people (15%). Meanwhile, mean brain natriuretic peptide (BNP) level was 1.93 ± 0.26 and normal samples in 3 people (7.5%) and increase in 37 people (92.5 %).

Conclusion : There is a positive correlation between inferior vena cava collapsibility index (IVCCI) and brain natriuretic peptide (BNP) to assess adequacy of stroke volume of septic patients treated in ICU Haji Adam Malik Hospital, Medan.

Keywords:- *inferior vena cava collapsibility index, brain natriuretic peptide, sepsis, intensive care unit*

I. INTRODUCTION

Sepsis is found in up to 1.7 million adult patients worldwide every year year and play a roleon250,000 Dead. Sepsis is reason most frequently found in critically ill patients, who Becomes reason half from Dead in house sick in America Union. (Abu-Zain, 2016)

Patients with sepsis experience altered delivery and use of oxygen, resulting from varying degrees of actual and relative intravascular volume depletion from decreased oral intake, increased involuntary fluid loss, vascular vasodilation, increased venous capacitance, and capillary leakage. The classical understanding is that during sepsis most patients experience "relative hypovolemia" and intravenous fluid administration increases preload, which increases cardiac output, and results in increased oxygen delivery to organs experiencing tissue hypoxia. (Airapetian, 2015)

Starling's law conceptualizes maintenance of vascular volume as the balance of the hydrostatic and oncotic pressure gradients between the vessel lumen and the interstitial space, which has recently been shown to be influenced by the endothelial glycocalyx. As a major determinant of membrane permeability, damage to the glycocalyx during sepsis can alter the patient's response to fluid resuscitation. Although the clinical implications of these findings are not yet fully understood (Brown et al., 2018).

A low blood volume status can lead to circulatory failure in patients with septic shock. Volume depletion can lead to tissue hypoperfusion, microcirculatory dysfunction, and vital organ failure. However, excess fluid expansion can also cause cardiac insufficiency, pulmonary edema, and other adverse clinical symptoms. Although it is very important to optimize cardiac preload immediately to maintain tissue perfusion in patients with severe sepsis, it is difficult to accurately evaluate cardiac preload status in patients during the early septic phase (Zhao et al., 2016).

Today, clinicians can measure CVP using the methodnon-invasive which could conducted with *transesophagealechocardiographyTEES*) and inspection ultrasound. And could taken conclusion that There is a significant correlation from ultrasound examination and the diameter of the veins Inferior Cava (VCI) with patient volume status(Angus, 2013) . Research on correlation diameter and *collapsibility index* with pressure veins central to evaluation Intra vascular volume status in septic patients at Rajavithi Hospital Bangkok, Thailand also gets a strong correlation (Prasert, 2013). Studyregarding the correlation between inferior vena cava diameter and central venous pressureformonitorfluidpatientwhichintake careinroomhousesickmilitaryRawalpindiPakistanonyear201

3,obtained correlation which strong Among inferior vena cava diameter and central venous pressure (Amir, 2015). This too supported by the results of Ginting's research, 2021 which found that there were correlation negative Among *inferior veins cava collapsibility index*(IVCCI) and central venous pressure (CVP) in assessing fluid adequacy in patients who are treated in Home ICUS ick Hajj Adam Malik Medan(Ginting, 2021).

The response to sepsis is a very complicated chain of events which concerning process inflammation and anti-inflammatory, hormones an dreaction mobile, as well as abnormality circulation. Identification more beginning on patient in room care intensive could help intervention therapeutic, like change further therapeutic protocols and diagnostic measures in the hope of preventing bad and failure organ which could influence output from patients (Angus, 2013) .

Prediction of intravascular fluid at Haji Adam General Hospital Malik Medan is often monitored by assessing central venous pressure rather than measurement collapsibility index with measure diameter maximum and at least the inferior vena cava. Referring to the description above, this research was conducted to determine the correlation between central venous pressure and the *collapsibility index veins cava inferior* with *brain natriureticpeptide*(BNP) for evaluate adequacy of stroke volume Septic patients admitted to the ICU Haji Adam Malik Medan.

II. METHODOLOGY

A. Design Study

This study is an observational analytic study with a *cross-sectional* survey study design to determine the relationship between the *inferior vena cava collapsibility* index (IVCCI) and *brain natriuretic peptide* (BNP) to assess the adequacy of stroke volume in septic patients hospitalized.ICU.

B. Place and time Study

The study was conducted at *the Intensive Care Unit* (ICU) General Hospital Haji Adam Malik Medan.

C. Time Study

The research was carried out after ethical clearance was issued by the Ethics Committee of the Faculty of Medicine, University of North Sumatra and H. Adam Malik Hospital, Medan until it was fulfilled sample.

D. Population and Sample Study

The population in this study were all patients treated in the ICU Haji Adam Malik Hospital, Medan. The research sample is primary data obtained from direct assessment and examination of patients who meet the inclusion criteria.

E. Subject Selection Study

Sampling technique used is non *-probability sampling*, namely *consecutive sampling*. *Consecutive sampling* is a sample selection technique in which all subjects who come and meet the inclusion criteria are included in the study until the number of subjects is required fulfilled.

F. Criteria inclusion

The inclusion criteria in this study were ages 18–65years, patients admitted toICU, and patients admitted to the diagnosis sepsis

G. Criteria Exclusion

The inclusion criteria in this study were patients who refused to be sampledresearch and patients with woundsburn

H. Procedure

This research was conducted after obtaining informed consent and was approved by the Health Research Ethics Commission, Faculty of Medicine, University of North Sumatra and RSUP H. Adam Malik Medan. The collection of research samples according to the inclusion and exclusion criteria in sepsis patients treated in the ICU H. Adam Malik Hospital Medan. Collecting basic data such as gender, age, admission diagnosis, BMI by volunteer. While in the ED, *a one-hour bundle* sepsis protocol was performed with an IVCCI examination and –taking blood BNP samples. Then at <12 hours of ICU admission, the inferior vena cava collapsibility index was reassessed using Doppler ultrasound. Where this examination is carried out by the researcher and confirmed by the supervisor ICU. The researchers assessed the relationship between the inferior vena cava collapsibility index and Brain Natriuretic Peptide with volume adequacy.

I. Design Analysis

After all the data is collected, the data is tabulated into a master table using *software*SPSS. Numerical data is shown in mean $\pm$ SD (*standard deviation)* and median (minimum-maximum) values, while categorical data is shown in sum(percentage). Normality test using normality test*Shapiro-Wilk* . The bivariate test was carried out using the *Chi-Square test* if the data was normally distributed, and using the Mann-Whitney test if the data was not normally distributed with a degree of significance.$p<0.05$.

J. Ethics

This research was conducted after obtaining approval from the Ethics Committee for Health, Faculty of Medicine, University of North Sumatra and H. Adam Malik Hospital, Medan. And the patient and the patient's family get an explanation about the procedure to be carried out and express their willingness in the Informed sheetConsent.

K. Result

This study is an observational analytic test with a *cross-sectional* survey study design to determine the relationship between the *inferior vena cava collapsibility* index (IVCCI) and *brain natriuretic peptide* (BNP) to assess the adequacy of stroke volume in septic patients hospitalized.ICU.

L. Characteristics Sample

This study was followed by 40 samples that have met the inclusion criteria. The characteristics of the research sample are shown in the form of frequency, average with standard deviation, as well as normality test is shown in table 4.

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Characteristics	Frequency	ScoreP *
Typesex(n,%)		
Man–Man	19(47.5 %)	0 , 12
Woman	21 (52.5 %)	
Age (Mean ± Std. Deviation)	43 ,43 ±1 3 , 25	0.24 _
BMI (Mean ± Std. Deviation)	24.29 ± 3.20	0, 10
Systolic (Mean ± Std. Deviation)	111.25 ± 19.27	0.08 _
Diastolic (Mean ± Std. Deviation)	65.95 ± 10.66	0.06
Nadi (Mean ± Std. Deviation)	109.35 ± 19.37	0.20

Table 1: Sample Characteristics

Based on table 1, the sample characteristics were obtained based on the sex of 19 (47.5%) male and 21 (52.5%). ± 3.20. The sample characteristics were based on systolic 111.25 ± 19.27 and diastolic 65.95 ± 10.66 with a mean pulse of 109.35 ± 19.37 where p value > 0.05, the sample characteristics were normally distributed.

M. Characteristics of IVVCI, BNP and Stroke Volume insample

Characteristics of IVCCI, BNP and stroke volume in septic patients admitted to the ICU Haji Adam Malik Hospital Medan can be seen in the table below :

Characteristics	Frequency	ScoreP *
IVCCI (Mean ± Std. Deviation)	1.65±0.73	
Decrease	20 (50%)	0.12
Normal	14 (35%)	
Increase	6 (15%)	
BNP (Mean ± Std. Deviation)	1.93±0.26	
Normal	3 (7.5 %)	0.32
Increase	37 (92.5%)	
Stroke Volume (Mean ± Std. Deviation)	1.23±0.53	0.26
Decrease	33 (82.5%)	
Normal	5 (12.5%)	
Increase	2 (5%)	
Total	40 (100%)	

Table 2: Characteristics of IVCCI, BNP and Stroke Volume in Samples

From table 2, the IVCCI characteristics of the sample obtained an average of 1.65±0.73 with amount which decrease as much 20(50%), normal 14(35%) and increase6(15%).Based on BNP sample obtained average 1.93±0.26 and the normal number was 3 (7.5%) and increased by 37 (92.5 %). Based on the stroke volume in the sample found an average of 1.23 ± 0.53 with a decrease of 33 (82.5 %), normal 5 (12.5%) and an increase of 2 (5%) where p value > 0.05 then sample characteristics are normally distributed.

N. IVCCI correlation with BNP on stroke volume

The characteristics of IVCCI with BNP to assess the adequacy of stroke volume can be seen from the following table :

	Stroke Volume				**P value***
	Decrease	**Normal**	**Increase**	**Total**	
IVCCI					
Decrease	16 (40%)	3 (7.5 %)	1 (2.5%)	20	
Normal	12 (30%)	2 (5%)	0 (0%)	14	0.42
Increase	5 (12.5%)	0 (0%)	1 (2.5%)	6	
Total	33	5	2	40	
BNP					
Normal	3 (7.5 %)	0 (0%)	0 (0%)	3	
Increase	30 (70%)	5 (12.5%)	2 (5%)	37	0.58
Total	33	5	2	40	

Table 3: Characteristics of IVCCI with BNP on Stroke Volume

Based on table 3, it can be seen that the number of IVCCI decreased the most in the decreased stroke volume

by 16 (40%) while BNP was found to increase the most in the decreased stroke volume by 30 (70%).

The correlation of IVCCI and BNP to stroke volume can be seen from table 4.

	IVCCI	BNP	P-value
Stroke Volume	0.83 [a]	0.53 [a]	0.02 [b]
	0.72 [a]		0.01 [b]

Table 4: Correlation of IVCCI with BNP on Stroke Volume

[a] Correlation coefficient (r value)
[b] Spearman

From table 4.4 showing the correlation between IVCCI and BNP on stroke volume, there is a very strong positive correlation between IVCCI and stroke volume where r = 0.83 with p = 0.02, and there is a moderate positive correlation between BNP and stroke volume where the value of r is = 0.53 with p value = 0.02.

While the correlation of IVCCI with BNP and its relationship with the status of the volume of the research sample using the Spearman correlation, there was a strong positive correlation between the two with values of r = 0.72 and p = 0.01.

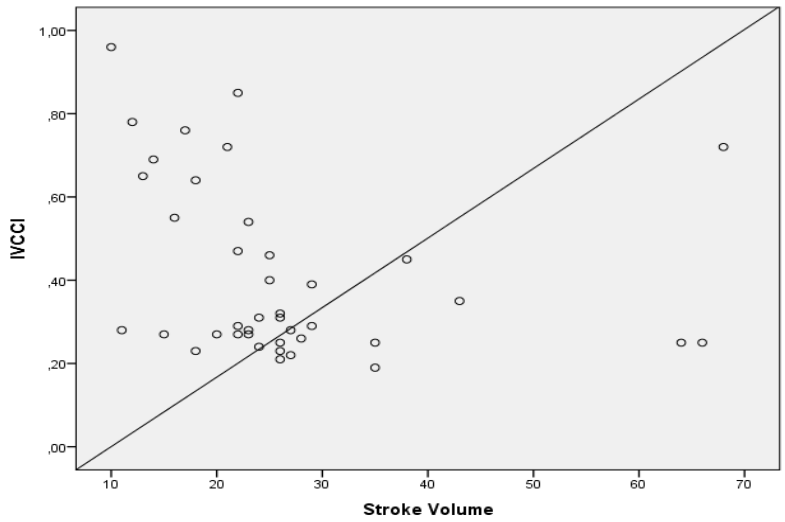

Fig. 1: Scatter plot of IVCCI correlation to stroke volume

Fig. 1 shows a very strong positive correlation between IVCCI and stroke volume where r = 0.83 with p = 0.02.

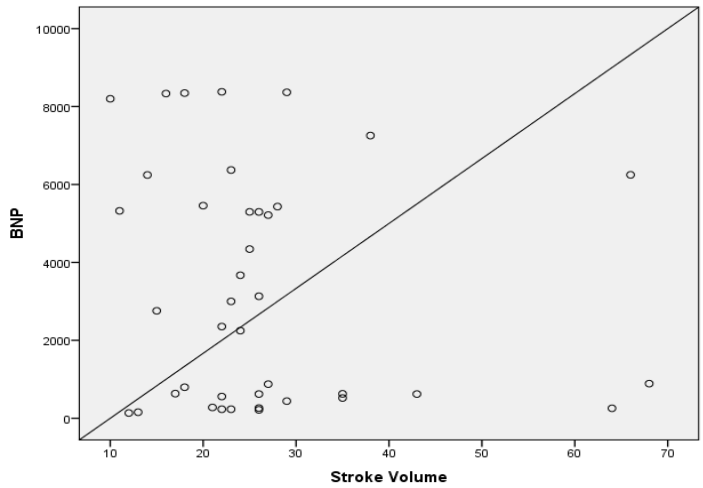

Fig. 2: Scatter plot of BNP correlation to stroke volume

Figure 2 shows a moderate positive correlation between BNP and stroke volume where r = 0.83 with p = 0.02.

III. DISCUSSION

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The results of this study indicate that the mean value of BNP is 1.93 1.93 ± 0.26, where 3 people (7.5%) are in normal values and as many as 37 people have an increase. This is in line with the theory presented by Kandil et al. (2008) and Bhandari and Cunningham (2020) that can cause myocardial dysfunction which manifests as ventricular dysfunction through increased levels of BNP. One of the continuing effects of sepsis is myocardial dysfunction. Where myocardial dysfunction is reflected in the BNP value as a result of stretching ventricle.

Meanwhile, the mean *stroke volume value* was 1.23 ± 0.53, where 33 people (82.5%) showed a decrease, 5 people (12.5%) were at normal values, and as many as 2 people (5%)) increased. In this study, it was found that the IVCCI value decreased the most in the decreased stroke volume by 16 (40%). These results indicate that a decrease in preload due to sepsis will decrease the measured value of IVCCI and an increase in preload due to fluid administration will increase the IVCCI value because the diameter of the inferior vena cava and the measured value of IVCCI are proportional to end-diastolic volume and cardiac output during volume expansion (Huang, 2019).)

This study showed that BNP was found to increase the most in decreased *stroke volume* by 30 (70%). This is due to a decrease in *stroke volume* in septic patients which can be caused by myocardial dysfunction that affects the increase in BNP. In addition, the state of sepsis also causes vascular leakage, vasodilation and hypotension, and septic cardiomyopathy will result in an increase in BNP. (Pandompatan et al., 2019 and Bass et al., 2021).

Based on the results of the study, the hypovolume state caused by either vasodilation or myocardial dysfunction in septic patients will affect IVCCI levels and plasma BNP values. In the setting of sepsis, decreased IVCCI values, accompanied by a decrease in *stroke volume* will result in hypovolume and myocardial dysfunction will result in an increase in plasma BNP values in response to abnormal stretching of the heart muscle. (Huang, 2019 and Bass et al., 2021). As previously explained by Nagi et al. (2021) and Bhandari and Cunningham (2020) that sepsis as a dysregulation of the *host* response to infection produces various *cytokines* which in addition to causing vasoplegia, venodilation, and reduced ventricular *compliance* also act as *circulating myocardial depressant substrates* that play a further role in the process. ventricular dysfunction in the advanced stages of sepsis. Therefore, with increased host response dysregulation, there will be a tendency to increase venodilation which can be assessed through IVCCI and an increase in *circulating myocardial depressant substrate* that causes ventricular dysfunction (increased BNP) (Nagi et al., 2021; Bhandari and Cunningham, 2020).

In a recent study of critically ill and mechanically ventilated patients with septic shock, as well as over 18 years of age, BNP levels were assessed following their stay in the ICU. Comparison of plasma BNP levels in the ICU between patients (849.4 ± 154.8 pg/mL) and healthy individuals (100 ± 9.4 pg/mL) showed that plasma BNP levels in patients with septic shock were significantly higher. The hypothesis here assumes that BNP is a marker for death in septic shock associated with impaired myocardial function. It is believed that ventricular dilatation and decreased LVEF and RVEF in the early phase of myocardial depression during septic shock will cause plasma BNP levels to rise. Among patients with septic shock who will survive, BNP will return to normal within the first ten days. Among patients with septic shock who are destined to die, however, BNP will remain within normal limits because their cardiac ventricles will not increase in size and their ejection fraction remains normal. (Castillo Jr et.al, 2004)

Based on the results of this study, it was found that there was a correlation between IVCCI and BNP on stroke volume, there was a very strong positive correlation between IVCCI and stroke volume where r = 0.83 with p = 0.02, and there was a moderate positive correlation between BNP and stroke volume where value of r = 0.53 with a value of p = 0.02. While the correlation of IVCCI with BNP and its relationship with the status of the volume of the research sample using the Spearman correlation, there was a strong positive correlation between the two with values of r = 0.72 and p = 0.01.

Data from one study showed that, compared with BNP and lactic acid values, IVC-VI, showed a stronger correlation with SOFA in patients with septic shock. The serum concentration of NT-proBNP at each time point was 8954.23 ± 8549.87 pg/mL. The value of lactic acid at each time point was 3.98 ± 1.47 mmol/L. IVC-VI at each time point was 0.42 ± 0.09. The EVLWI at each time point was 12.38 ± 3.33. IVC at each time point was 2.22±0.46. (Huan C et.al, 2019)

Our study adds to the evidence that IVC, which is derived by graphical ultrasound, is potentially useful for evaluating volume status in septic shock patients. These findings are important to carry out serial measurements for further prospective IVC. Larger sample sizes and sufficient statistical power are needed to clarify current issues regarding the use of IVC in the field of septic shock. Ultrasonographic assessment of the IVC may be recommended as a non-invasive and sustainable method for predicting fluid response in mechanically ventilated patients with septic shock. Early recognition and appropriate treatment of shock have been shown to reduce mortality. With the increasing incidence of sepsis and its complications, rapid and detailed research is becoming increasingly important. Our work makes a significant contribution to knowledge of the early detection of septic shock. This is the first clinical study to assess the effect of IVC for fluid resuscitation in patients. (Huan C et al.,2019)

IV. CONCLUSION

The characteristics *of the inferior vena cava collapsibility index* (IVCCI) of septic patients admitted to the ICU of Haji Adam Malik Hospital Medan obtained an average of 1.65 ± 0.73 with a decrease of 20 (50%), normal 14 (35%) and an increase of 6 (15%). *Brain natriuretic peptide (BNP)* levels of septic patients treated in the ICU Haji Adam Malik Hospital Medan obtained an average of

1.93 ± 0.26 and a normal number of 3 (7.5%) and an increase of 37 (92.5%). There is a positive correlation *inferior vena cava collapsibility index* (IVCCI) with *brain natriuretic peptide* (BNP) to assess the adequacy of stroke volume in septic patients treated in the ICU Haji Adam Malik HospitalMedan.

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